SMALL MAMMAL SURVEYS ON GRANT-KOHRS RANCH NATIONAL HISTORIC SITE

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Final Report

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by

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Introduction

The current report provides the results of a small mammal survey conducted on Grant-Kohrs Ranch National Historic Site (GKR) in the summers of 2002 and 2003. The primary objective was to survey the small mammals of GKR in an effort to achieve a 90% inventory of the small mammal communities there. Given the potentially high species richness and the potential rarity of some prospective community members, we conducted intensive sampling throughout GKR using a range of trapping techniques to ensure that the suite of traps provided the most effective means of sampling the entire small mammal community. Additionally, the use of snap traps and pitfalls provided voucher specimens for identification purposes. Since at least one fourth of the species potentially present are difficult to impossible to conclusively identify without using dental, skull, or baculum characteristics (e.g. nearly all the shrews, several voles, and some chipmunks and mice), examination of these characteristics were necessary to approach the 90% census goal and establish conclusive species identifications. A secondary objective of this study was to evaluate small mammal habitat use in the context of exotic plant invasions occurring within the park.

Methods

We developed a prospective species list (Table 1) for GKR by examining small mammal distribution records for Powell County (Foresman 2001a) to provide a starting point for developing our survey. We developed this prospective species list in the context of the habitat associations known for these animals given the habitats present on GKR. However, the list was intended to be overly inclusive to ensure we did not overlook any potential species we might encounter in developing survey protocols. Based on this list, and the knowledge that many traps have inherent biases in their ability to detect different species (Martel 1979, Innes and Bendell 1988, Allen et al. 1997), we developed an intensive survey employing a range of trap types that included: Sherman live traps (7.6 x 8.9 x 22.9 cm), number 202 Tomahawk live traps (47 x 15 x 15 cm), pitfall traps (large coffee cans 50 cm diam by 17 cm tall), Museum Special snap traps, standard small snap traps, and gopher traps. After an initial visual walk-through and survey of the different habitats on GKR, we developed a protocol to maximize the coverage of different habitats by deploying the various trap types along transects and at spot trapping locations throughout the park. Specific traps were deployed over different distributions and time frames as described below, but overall approximately 3 weeks of sampling occurred in August each year. The entire sampling effort was replicated for two years to account for the notable variability associated with small mammal populations (Krebs 1996) that can result in very low densities of a range of species during any single year. The beginning and end points of each transect were recorded using a global positioning system unit (GPS: see Appendix 1).

Live Trap Sampling

Live trapping was conducted by setting out traps along transects (Pearson and Ruggiero 2003) spaced at 10-m intervals. Live traps were run for four-day intervals on each transect before shifting them to new locations. Traps were baited with peanut butter and oats, and checked each morning. Live-trapped animals were identified to species, weighed, ear tagged (#1005 finglerling ear tags), and their sex, age, and reproductive

condition was determined before being released at the trap station (Pearson et al. 2001). Tomahawk traps were strategically placed near burrow entrances, shrubby habitats, and rocky outcrops to target larger small mammals like ground squirrels, chipmunks, and wood rats based on habitat associations for these species (Pearson 1999, Foresman 2001a). Visual and audio surveys were conducted in appropriate habitats for marmots and tree squirrels. The visual and audio surveys were not standardized.

Snap Trap and Pitfall Sampling

Snap traps were set out along transects at 10 m spacing and run for three days per week. Traps were baited with peanut butter and checked each morning. After three days, snap traps were rotated to new locations. Pitfall traps were set into the ground so the tops were level with the ground surface, and they were baited with peanut butter and partially filled with water. Pitfall locations were coordinated with the chief ranger of GKR to ensure sensitive areas were not disturbed. Pitfalls were checked once each day and run for approximately 10 days. Gopher traps were used to target pocket gopher tunnels. Captured animals were processed as described above for live trapping and were then bagged and placed on ice until they could be frozen. A subset of specimen skulls and or skins were prepared (see below) and retained for voucher specimens, which were submitted to GKR (Appendix 2).

Vegetation Sampling

Trapping effort was stratified to cover the full range of vegetation types available. Cover estimates of habitat variables such as bare ground, rock, litter and dominant species of native and nonnative vegetation were made by visually estimating the percent cover of each species within a 3-m radius of the trap station on live trap transects (after Pearson et al. 2000, 2001). Vegetation along the snap trap transects and at other trapping locations was simply assigned to a dominant vegetation type for all the unique vegetation zones along transects.

Specimen Identifications and Specimen Collections

Specimen collections focus on smaller taxa, particularly those that are difficult to identify. Specimens were identified by D. Pearson and B. Holmes and independently confirmed by S. Carter and K. R. Foresman using Hoffman and Pattee (1968) and Foresman (2001b). We attempted to prepare a voucher collection comprised of one or two specimens of each species whenever damage by traps or heat did not destroy specimens. All standard museum measurements including the total length of the specimen from the tip of the nose to the end of the tail, tail length, right ear and left hind foot length, and weight were made prior to preparation of specimens (Hall 1962) and are recorded in Appedinx 2.

Analytical Methods

Species effort curves were constructed from the survey data to provide some measure of the degree of success in achieving the 90% census goal. Species effort curves were constructed by graphing the cumulative number of species against the cumulative sampling effort, where sampling effort was broken into six 1-week periods comprising three weeks of trapping in 2002 and three weeks of trapping in 2003. These curves

should reach an asymptote and level out if additional effort is generating relatively few new species (Palmer 1990), indicating that most species have been sampled.

Logistic regression was used in the context of resource selection function analysis (Manly et al. 1993) to determine significant variables separating trap stations capturing animals from those not capturing animals for each year separately where sufficient data was available for separate analyses. Trap stations were only used once, i.e., multiple captures at a station result in that station being classified as a capture station (after Pearson et al. 2001). Analyses were conducted only for live trapping stations because these are the only places where intensive vegetation data were gathered, and analyses were conducted only for those species having sufficient captures to effectively evaluate habitat use. Habitat variables were lumped into exotic grass, native grass, exotic forb, native forb, shrub, bare ground and rock. The primary focus was on exotic versus native vegetation for the primary plant functional groups of grasses and forbs. Bare ground and rock were included because these have previously been shown to represent important habitat variables for small mammals in similar systems (Pearson et al. 2001). Sedge (*Carex* spp.) was also included because it was an important plant group indicative of mesic habitat with high graminoid cover.

Results

Total trapping effort at GKR each year was approximately 1400 trap nights (1 trap night = 1 24-hr period per trap) for live traps, 2340 trap nights for Museum Special snap traps, 50 trap nights for pitfalls, and approximately 207 trap nights for Tomahawks, standard snap traps and gopher traps. Tomahawks, standard snap traps, and gopher traps were used to target specific species based on habitat and reconnaissance information. This total sampling effort approximated 4000 trap nights along more than 11 km of transects at more than 45 locations in each year at GKR (Fig. 1).

In 2002, trapping resulted in approximately 199 captures of 198 individuals (Table 2). Nine species of small mammals were identified from trapping results: vagrant shrew (*Sorex vagrans*), masked shrew (*S. cinereus*), northern water shrew (*S. palustris*), northern pocket gopher (*Thomomys talpoides*), meadow vole (*Microtus pennsylvanicus*), montane vole (*M. montanus*), deer mouse (*Peromyscus maniculatus*), house mouse (*Mus musculus*), and yellow-pine chipmunk (*Tamias amoenus)*. A young western toad (*Bufo boreas*) was also captured in a pitfall. In addition to trapping, visual observations were made of white-tailed deer (*Odocoileus virginianus*), a porcupine (*Erithizon dorsatum*), a mountain cottontail (*Sylvilagus nuttallii*) and a muskrat (*Ondatra zibethicus*) on the ranch (Table 3). A red fox (*Vulpes vulpes*) and a badger (*Taxidea taxus*) were observed in areas adjacent to the ranch, and these species undoubtedly occur on the ranch as well.

In 2003, the same trapping effort was repeated over the same locations, producing 183 captures of 173 individuals representing ten species of small mammals including: the vagrant shrew, montane shrew (*S. monticolus*), masked shrew, northern water shrew, meadow vole, montane vole, deer mouse, house mouse, yellow-pine chipmunk, and western jumping mouse (*Zapus princeps*). In addition, visual observations were made of Columbian ground squirrels (*Spermophilus columbianus*) and coyotes (*Canis latrans*) on GKR (Table 3). Visual observations were again made of red foxes adjacent to the ranch. The montane shrew, western jumping mouse, and Columbian ground squirrel were new

species for the survey in 2003. Capture locations for rare and uncommon species are shown in Fig. 2.

The species-effort curve climbed dramatically in the first year then leveled off very rapidly by the end of the first year (Fig. 3). Although a couple of species were still added during the trapping survey in the second year, the curve appears to have asymptoted and leveled off suggesting that most species were probably detected by the end of the second year, and additional new species will tend to be added rather slowly at this point.

Sufficient capture data for habitat analyses were available only for deer mice and voles. Voles were treated collectively as *Microtus* species including *Microtus pennsylvanicus* and *Microtus montanus* because live captured voles were not identified to species. However, based on identifications of trap mortalities, all but a few of these were likely meadow voles (*M. pennsylvanicus*). Based on the 14 live transects available for habitat analysis, deer mice and voles exhibited a distinct separation at the macrohabitat level. Mice and voles were never caught on the same transects in either year. At the macrohabtiat level, voles tended to favor transects with high vegetative cover, i.e., very low values for bare ground, that tended to differ from other transects in having abundant sedge. Deer mice on the other hand tended to occur on transects with more bare ground and more native grass. Microhabitat analyses based on backward stepwise logistic regression of habitat variables at trap stations within transects resulted in significant models for both voles and mice (Figs. 4-5). The final model for voles ($\chi^2 = 77.00$, df = 2 = $P < 0.001$) included native forb ($\beta = -0.022$, Wald = 2.51, df = 1, $P = 0.113$) and bare ground ($\beta = -0.226$, Wald = 16.37, df = 1, $P < 0.001$). The final model for deer mice ($\chi^2 = 37.83$, df = 4 = $P < 0.001$) included sedge ($\beta = -3.919$, Wald = 0.001, df = 1, $P = 0.978$), native forb ($\beta = -0.074$, Wald = 4.93, df = 1, $P = 0.026$), bare ground ($\beta = -0.020$, Wald = 2.95, df = 1, $P = 0.086$), and rock ($\beta = 0.088$, Wald = 13.73, df = 1, $P < 0.001$).

Discussion

This two-year survey of small mammals on GKR has significantly expanded the mammal species list by adding nine new species of small mammals to the park inventory and confirming an additional species that was previously listed but not confirmed (Table 1). Trapping in the first year added six species to the park list: masked shrew, northern water shrew, northern pocket gopher, montane vole, house mouse, and yellow-pine chipmunk. The chipmunk was identified as a yellow-pine chipmunk based on habitat and distribution. The house mice were captured in the barn. No house mice were captured in natural habitats. In addition, a porcupine was visually observed on the southwest corner of the park. This is also a new species for the park. In the second year, trapping added two more new species to the list, the montane shrew and western jumping mouse. In addition, visual observations in the second year confirmed the presence of the Columbian ground squirrel, a species that was listed in the National Park Service database for GKR as probable based on interpretive materials. The masked shrew, vagrant shrew, northern water shrew, northern pocket gopher, and house mouse records provide the first documentation of these species in Powell County based on Foresman (2001a). We also captured one small western toad in a pitfall trap. This species was previously know for the park and had been recently documented in reptile and amphibian surveys for GKR (Hossack et al. 2001).

The species effort curve for this survey indicates that the second year of trapping was mostly redundant, but did provide two additional species (Fig. 2). The leveling off of this curve is a good indication that the survey effectively captured most, perhaps all, of the common species as well as many of the less common ones. The fact that the second year resulted in only two new species, indicates that adding further to this list would require a great deal of effort to achieve increasingly smaller returns for the inventory.

Species not detected on GKR that would be expected to be there include bushy-tailed woodrats (*Neotoma cinerea*) and yellow-bellied marmots (*Marmota flaviventris*). The ranch hand, Jessy Harris, believed that woodrats were present in some of the outbuildings. We trapped for woodrats in some of the outbuildings, but never captured any. However, it is quite possible that this species occurs in the outbuildings or in cottonwood trees (*Populus trichocarpa*) that occur in small patches in a couple of areas on GKR or in rock piles or trash piles within GKR. Yellow-bellied marmots were not captured or detected, but there was substantial habitat for them on the ranch. After spending substantial time and effort on the ranch it seems reasonable to remove several species from the prospective species list in Table 1, which was intended to provide an overly inclusive initial list for the survey. Snowshoe hares, golden-mantled ground squirrels, Richardson's ground squirrels, and red-tailed chipmunks all seem unlikely to occur on GKR. Additionally, although there is historical evidence of their presence (Table 1), black-tailed prairie dogs probably do not presently occur on GKR. Given the highly visible nature of prairie dogs and prairie dog sign, we likely would have observed them. Removing these species from the list of potential species in Table 1 reduces the total possible species to 25. Of these 25 species, we detected 15 or 60%. Given the species-effort curve and the highly visible nature of some of these species when they are present such as jack rabbits and tree squirrels, this 60% census is probably a low estimate, but it is also quite possible that some species such as tree squirrels not currently detected could occur periodically on the ranch given there is limited habitat available to them. In addition, it seems reasonable to add red foxes and badgers to the park list as probably present given their proximity to the park and the extent of suitable habitat available to them there.

Examination of habitat features on the live trap transects associated with mice or vole captures indicated that the voles were most closely associated with habitats with high vegetative cover and very little bare ground and were particularly closely associated with habitats containing sedge, whereas mice were never caught on the same transects as voles and were associated with transects having lower vegetative cover and higher bare ground. In general, transects with mice were more xeric upland habitats generally high in native grasses, but low in overall cover. The microhabitat analysis for voles showed that voles avoided native forbs and bare ground. The stronger variable was the avoidance of bare ground and is consistent with the high cover demands of these species (Foresman 2001a). The avoidance of native forbs was probably more reflective of unique sites with higher graminoids either in the form of sedges or grasses. Microhabitat selection by mice involved an avoidance of sedge, native forbs, and bare ground, and selection for rocky sites. Avoidance of sedge and native forbs probably indicated avoidance of moister sites and high cover. Avoidance of bare ground is unusual for this species (Elliott et al. 1997, Pearson et al. 2001), but may reflect the fact that mice were only found on transects where average cover of bare ground was relatively high, leaving them selecting within

these low cover transects for microsites with less bare ground or more cover. Selection for rocky habitats is consistent with other studies of this species (Pearson et al. 2001, Pearson and Ruggiero 2004). We detected no evidence of significant selection for or avoidance of exotic plants by either species of small mammal based on these analyses. Thus, although exotic plants area clearly invading the native habitats on GKR, our analysis did not yet detect a strong negative response to this invasion in contrast to a similar analysis for Little Bighorn Battlefield National Monument (Pearson et al. 2006) and for Glacier National Park (Pearson and Ruggiero 2004).

Consistent with other studies of small mammals in xeric grasslands of Montana (Pearson et al. 2001, Pearson and Ruggiero 2004, Pearson et al. 2006), deer mice were by far the most abundant small mammal captured, dominating all habitats except wetter areas with heavy grass cover and hayfields. Meadow voles were the next most common and dominated in the hayfields and heavy mesic grassy areas. Vagrant shrews were third most abundant and were captured sporadically in various habitat types, but tended toward the wetter areas. Pocket gophers and yellow-pine chipmunks were also reasonably common though they are not particularly abundant in the trapping data set. The remaining species were relatively uncommon or rare. Their locations are mapped in Figure 2.

Although we cannot say with any certainty whether this small mammal survey achieved a 90% census, it is likely it has come very close to this, especially if only permanent resident small mammals are considered. Species listed in Table 1; no doubt include several species which may occur only sporadically on GKR due to minimal availability of suitable habitats. The species effort curve suggests that this survey is probably reasonably close to the 90% census goal and that additional species will likely be obtained only through significant additional effort or fortuitous events.

Acknowledgments

We would like to thank Ben Bobowski who was extremely hospitable in providing access throughout the park for the survey. Jessy Harris generously introduced us to GKR and provided assistance whenever needed. We thank Jack Potter for coordinating this project with the National Park Service. The hard work of Andrew Van Eck and Ray Selby in the field made the magnitude and extent of this survey possible. Elizabeth Edlund, Becky Bigley, Brian Holmes, and Kate Shick prepared small mammal specimens. David Pillmore provided access to the NPS database for GKR. We thank Kerry Foresman, Steve Carson, and Brian Holmes for verifications of small mammal identifications. This project was funded by the USDI National Park Service and by the USDA Rocky Mountain Research Station.

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Table 1. Small mammals occurring on or potentially occurring on Grant-Kohrs Ranch Historic Site based on surveys and county records (Foresman 2001a). The species list represents possible species as determined from occurrence and habitat information. The "prior" column shows species listed for the park as present or possibly present before this survey. The "current" column indicates species trapped or observed in the current survey. ○ indicates species listed in the park data base but not confirmed as present on the park. ● indicates species confirmed for the park prior to this survey. ☼ indicates species identified through trapping or visual observations for the park during this survey.

Order	Common name	Scientific name	Prior	Current
Insectivora				
	Cinereus shrew	*Sorex cinereus*		☼
	Pygmy shrew	*Sorex hoyi*		
	Montane shrew	*Sorex monticolus*		☼
	Water shrew	*Sorex palustris*		☼
	Preble's shrew	*Sorex preblei*		
	Vagrant shrew	*Sorex vagrans*	●	☼
Lagomorpha				
	Snowshoe hare	*Lepus americanus*		
	White-tailed jackrabbit	*Lepus townsendii*		
	Mountain cottontail	*Sylvilagus nuttallii*	●	☼
Rodentia				
	Beaver	*Castor canadensis*	○	
	Porcupine	*Erithizon dorsatum*		☼
	Muskrat	*Ondatra zibethicus*	●	☼
	Northern pocket gopher	*Thomomys talpoides*		☼
	Long-tailed vole	*Microtus longicaudus*		
	Montane vole	*Microtus montanus*		☼
	Meadow vole	*Microtus pennsylvanicus*	●	☼
	Heather vole	*Phenacomys intermedius*		
	Bushy-tailed woodrat	*Neotoma cinerea*		
	Deer mouse	*Peromyscus maniculatus*	●	☼
	House mouse	*Mus musculus*		☼
	Yellow-bellied marmot	*Marmota flaviventris*		
	Northern flying squirrel	*Glaucomys sabrinus*		
	Eastern fox squirrel	*Sciurus niger*		
	Red squirrel	*Tamiasciurus hudsonicus*		
	Columbian ground squirrel	*Spermophilus columbianus*	○	☼
	Golden-mantled ground squirrel	*Spermophilus lateralis*		
	Richardson's ground squirrel	*Spermophilus richardsonii*		
	Yellow-pine chipmunk	*Tamias amoenus*		☼
	Red-tailed chipmunk	*Tamias ruficaudus*		
	Black-tailed prairie dog	*Cynomys ludovicianus*	○	
	Western jumping mouse	*Zapus princeps*		☼

Table 2. Number of individual small mammals captured by species at Grant-Kohrs Ranch National Historic site in 2002 and 2003. Where there were recaptures of live individuals, the total number of captures is indicated in parentheses.

Common Name	Scientific Name	2002	2003
Vagrant shrew	*Sorex vagrans*	5	18
Montane shrew	*Sorex monticolus*	0	2
Masked shrew	*Sorex cinereus*	5	3
Northern water shrew	*Sorex palustris*	1	1
Shrew	*Sorex spp.*	0	1
Northern pocket gopher	*Thomomys talpoides*	1	0
Meadow vole	*Microtus pennsylvanicus*	23	45 (46)
Montane vole	*Microtus montanus*	3	8
Vole	*Microtus spp.*	10	12 (13)
Deer mouse	*Peromyscus maniculatus*	136 (137)	71 (79)
House mouse	*Mus musculus*	7	3
Yellow-pine chipmunk	*Tamias amoenus*	7	8
Western jumping mouse	*Zapus princeps*	0	1

Table 3. Visual observations made at Grant-Kohrs Ranch National Historic site in 2002 and 2003.

Common Name	Scientific Name	2002	2003
White-tailed deer	*Odocoilius virginianus*	X	X
Porcupine	*Erithizon dorsatum*	X	
Mountain cottontail	*Sylvilagus nuttallii*	X	X
Muskrat	*Ondatra zibethicus*	X	
Columbian ground squirrel	*Spermophilus columbianus*		X
Red fox	*Vulpes vulpes*	X	X
Coyote	*Canis latrans*		X
Badger	*Taxidea taxus*	X	

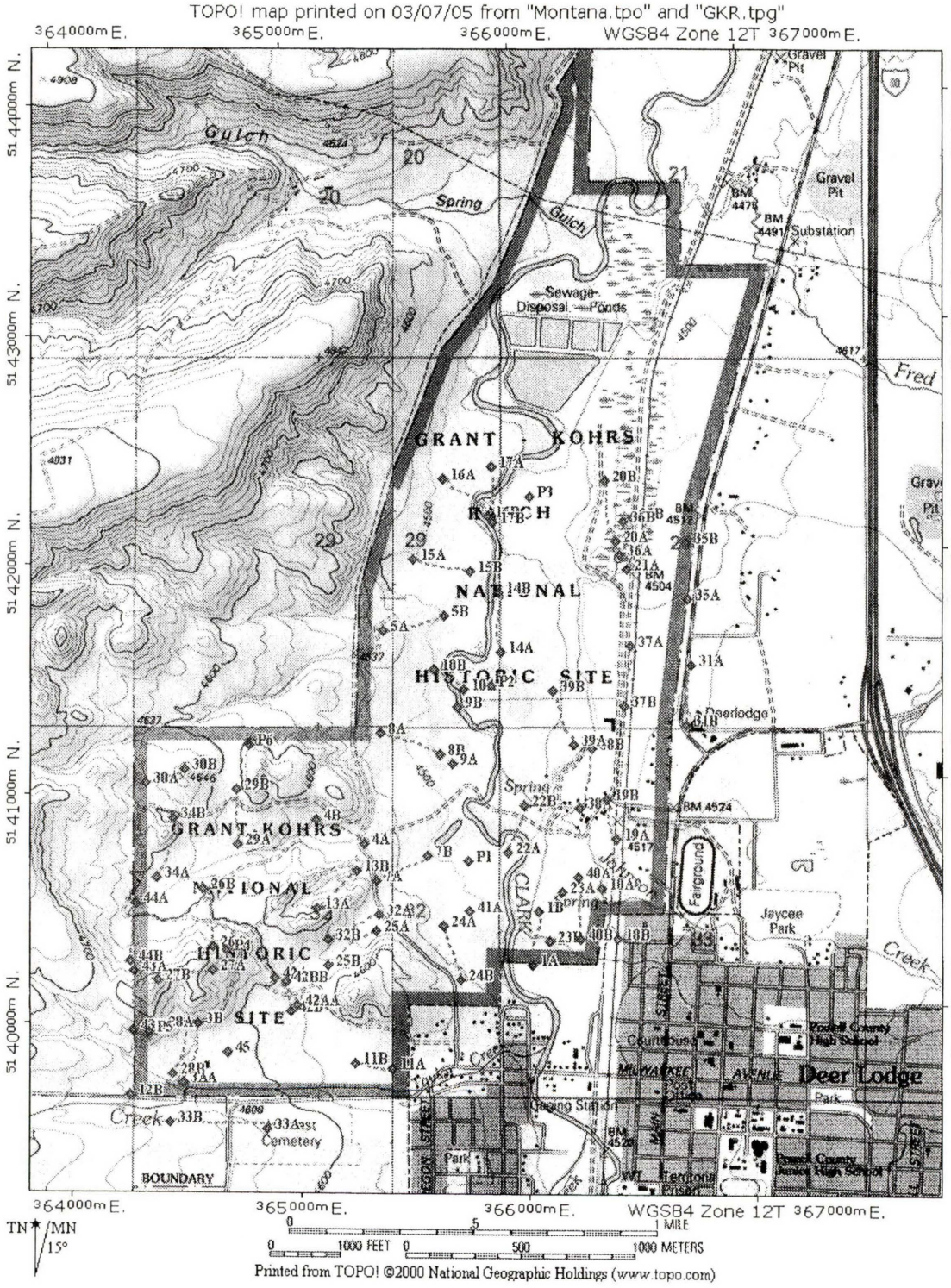

Fig. 1. Map showing distribution of trapping effort across Grant-Kohrs Ranch National Historic Site. Letters and numbers indicate first and last trapping stations for a given transect or trapping site. Some locations are only points from spot trapping.

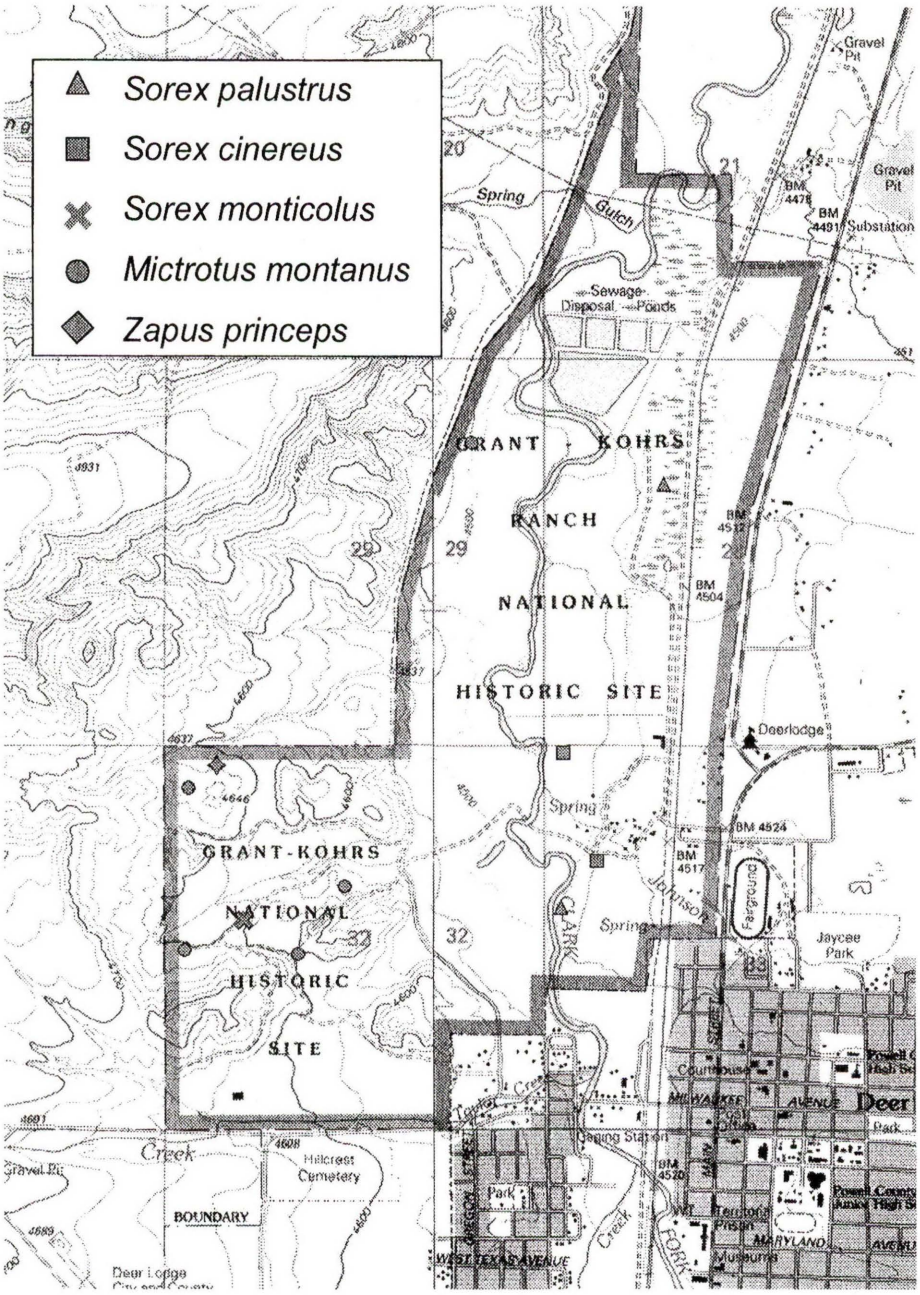

Figure 2. Locations of uncommon or rare species based on observations and trapping on Grant-Kohrs Ranch National Historic Site 2003-2003.

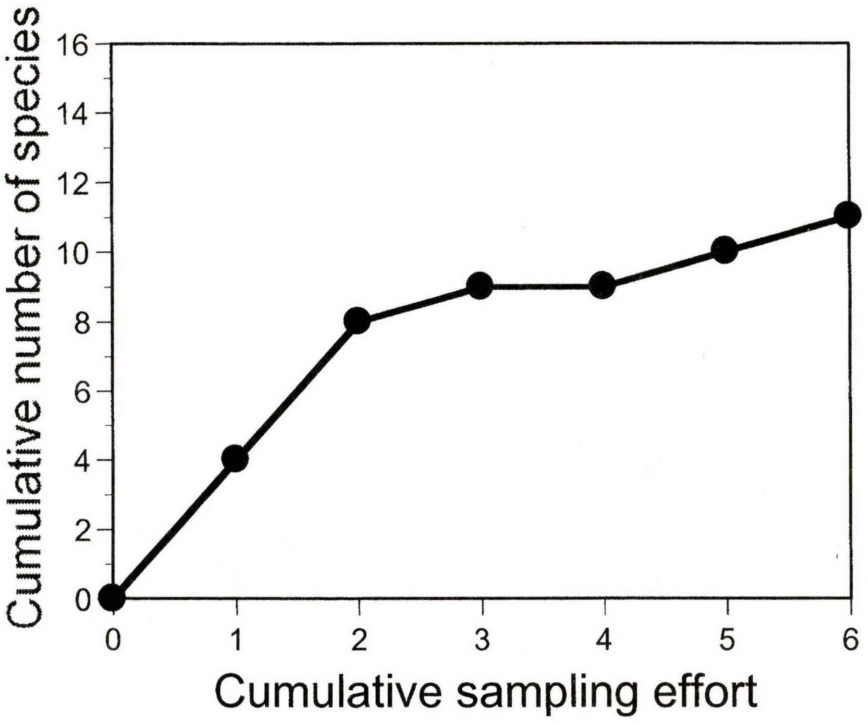

Figure 3. Species-effort curve showing the cumulative number of species captured versus cumulative sampling effort. Each sampling period is a week of sampling effort. The first three periods represent the three weeks of sampling in 2002 and the second three represent the three weeks of sampling effort in 2003. Data apply to trapping results only. Visual observations are not included.

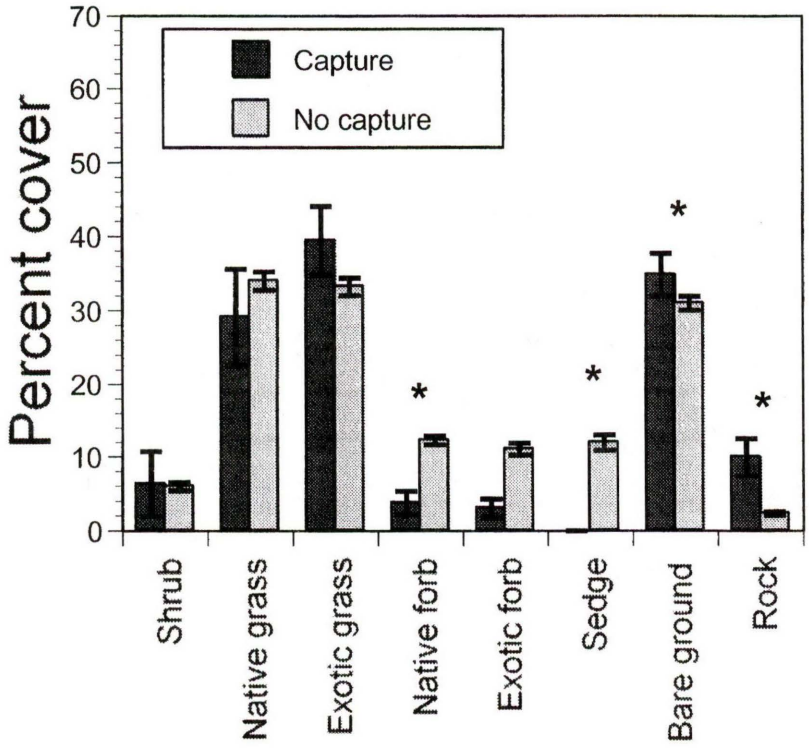

Figure 4. Habitat attributes ($\bar{x} \pm$ SE) for live trapping stations where deer mice were captured versus stations where deer mice were not captured at Grant-Kohrs Ranch National Historic Site from 2002-2003. Data were pooled for 2002-2003 due to small sample sizes in individual years. Asterisks indicate significant variables from logistic regression models.

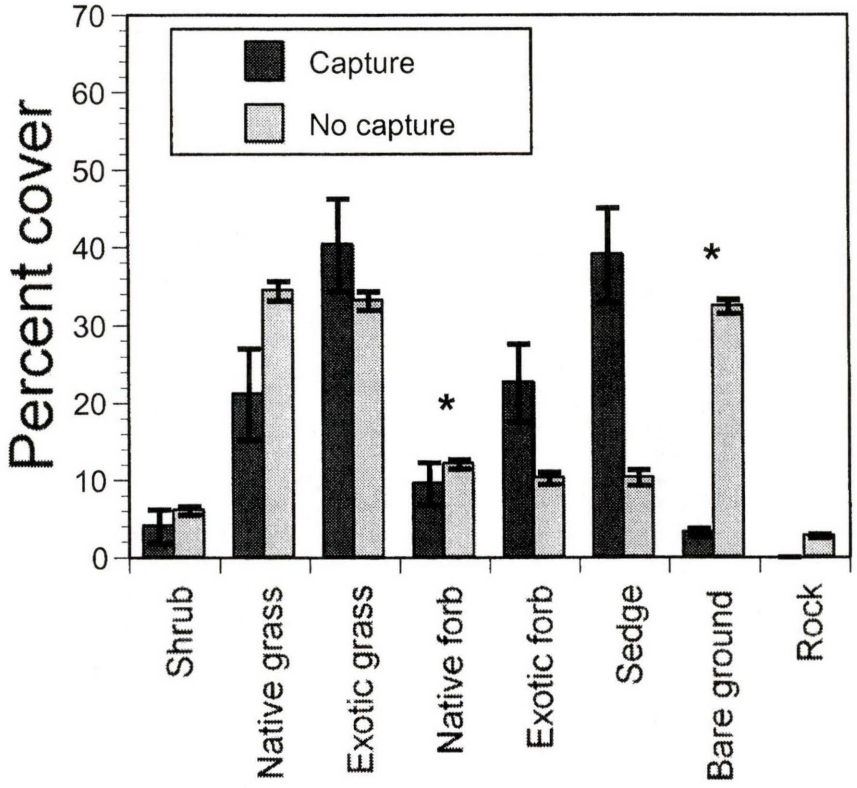

Figure 5. Habitat attributes ($\bar{x} \pm$ SE) for live trapping stations where voles (meadow voles and montane voles combined) were captured versus stations where voles were not captured at Grant-Kohrs Ranch National Historic Site from 2002-2003. Data were pooled for 2002-2003 due to small sample sizes in individual years. Asterisks indicate significant variables from logistic regression models.

Appendix 1. Grant Kohrs National Historic Site GPS coordinates and vegetation types at trap locations 2002-2003 (GPS NAD 83 / WGS84 DATUM). First trap coordinates correspond with first trap in the transect (A on map) and last trap coordinates with the last trap in the transect (B on map).

		First Trap		Last Trap		
Trans	**Trap Type**	**Easting**	**Northing**	**Easting**	**Northing**	**Dominant veg**
1	LIVE	366029	5140212	366060	5140444	Shrub, Cheat grass
3	LIVE	364489	5139728	364555	5139985	Needle-and-thread grass
4	LIVE	365304	5140760	365093	5140870	Needle-and-thread grass, Native forb
5	LIVE	365407	5141681	365670	5141741	Bluebunch wheatgrass, Sedge
7	SNAP	365355	5140597	365576	5140697	Cheatgrass, Bluebunch Wheatgrass
8	SNAP	365385	5141234	365640	5141139	Cheatgrass
9	SNAP	365697	5141099	365722	5141341	Native Forb
10	SNAP	365749	5141415	365621	5141509	Sedge
11	SNAP	365495	5139771	365245	5139800	Needle-and-thread grass, Cheatgrass
12	SNAP	364492	5139730	364256	5139673	Cheatgrass, Bluebunch wheatgrass
13	SNAP	365088	5140475	365265	5140641	Cheatgrass, Bluebunch wheatgrass
14	SNAP	365917	5141579	365915	5141838	Sedge, Bluebunch wheatgrass
15	SNAP	365541	5141991	365791	5141931	Cheatgrass, Bluebunch wheatgrass
16	SNAP	365679	5142343	365869	5142174	Needle-and-thread grass
17	LIVE	365890	5142389	365893	5142147	Bluebunch wheat grass, Sedge, Native forb
18	LIVE	366342	5140542	366408	5140316	Native Forb, Sedge
19	LIVE	366411	5140756	366370	5140933	Kentucky Bluegrass
20	LIVE	366436	5142055	366388	5142319	Needle-and-thread grass, Knapweed
21	SNAP	366477	5141927	366508	5142154	Sedge, Horse tail
22	SNAP	365932	5140706	366004	5140914	Cheatgrass
23	SNAP	366167	5140528	366109	5140314	Cheatgrass, Bluebunch wheatgrass
24	SNAP	365642	5140388	365711	5140153	Cheatgrass, Bluebunch wheatgrass
25	SNAP	365351	5140375	365135	5140226	Needle-and-thread grass, Bluebunch wheatgrass
26	SNAP	364631	5140318	364593	5140572	Cheat grass
27	SNAP	364626	5140214	364388	5140179	June grass, Bluebunch wheatgrass
28	SNAP	364396	5139972	364444	5139767	Needle-and-thread grass, Bluebunch wheatgrass
29	SNAP	364750	5140767	364748	5141007	Crested wheatgrass
30	SNAP	364354	5141040	364525	5141098	Cheat grass, Bluebunch wheatgrass
31	LIVE	366753	5141505	366724	5141242	Bluebunch wheatgrass, Cheatgrass, Knapweed
32	LIVE	365363	5140446	365137	5140340	Needle-and-thread, Bluebunch wheatgrass
33	LIVE	364854	513951	364429	5139555	Smooth Brome
34	LIVE	364391	5140630	364467	5140885	Needle-and-thread grass, Bluebunch wheatgrass
35	SNAP	366743	5141790	366742	5142034	Needle-and-thread grass, Knapweed
36	SNAP	366451	5141994	366472	5142269	Needle-and-thread grass
37	SNAP	366490	5141590	366455	5141334	Cheatgrass, Needle-and-thread grass
38	SNAP	366249	5140897	366308	5141150	Timothy
39	SNAP	366231	5141169	366143	5141402	Sedge
40	SNAP	366237	5140592	366244	5140322	Timothy
41	SNAP	365762	5140460	365834	5140248	Cheat grass, Bluebunch Wheatgrass
42	SNAP	364899	5140175	364967	5140030	Alfalfa
43	SNAP	364287	5140039	364287	5139845	Cheat grass
44	SNAP	364251	5140074	364287	5140349	Bluebunch Wheatgrass
45	SNAP, RAT,	364687	5139858	N/A	N/A	Needle-and-Thread grass
46	SNAP, RAT,	N/A	N/A	N/A	N/A	Open ground, Rock
47	SNAP, RAT,	N/A	N/A	N/A	N/A	Exotic Forb
42AA	SNAP	364891	5140182	364947	5140059	Timothy, Cheatgrass, Alfalfa
42BB	SNAP	364996	5140053	364945	5140159	Timothy
P1	PITFALL	365757	5140672	N/A	N/A	Cheatgrass, Sedge
P2	PITFALL	365870	5141432	N/A	N/A	Cheatgrass, Bluebunch Wheatgrass
P3	PITFALL	366057	5142260	N/A	N/A	Shrub, Cheatgrass
P4	PITFALL	364688	5140300	N/A	N/A	Cheatgrass
P5	PITFALL	364347	5139950	N/A	N/A	Bluebunch wheatgrass, Native Forb
P6	PITFALL	364806	5141193	N/A	N/A	Knapweed, Cheatgrass, Bluebunch wheatgrass

Vegetation Key: Alfalfa: *Medicago sativa;* Bluebunch wheatgrass: *Pseudoroegneria spicata*; Cheatgrass: *Bromus tectorum*; Crested wheatgrass: *Agropyron cristatum;* Common timothy: *Phleum pretense;* Exotic forb: Various exotic forb species; Horsetail: *Equisetum* spp.; June grass: *Koeleria cristata;* Knapweed: *Centaurea maculosa;* Native forb: Various native forb species; Needle-and-thread grass: *Stipa comata;* Sedge: *Carex* spp.; Shrub: Various species; Smooth brome: *Bromus inermis*

Appendix 2. Museum specimens from small mammal survey on Grant Kohrs National Historic Site.

Species	Number	UTMe	UTMn	Mo	Day	Year	Tran	Trap	Age	Sex	Skin	Skull	Total	Tail	Hindfoot	Ear	Wt
MIMO	131402	365088	5140475	7	28	2002	13	14	A	M	YES	YES	140	36	18	7	35
MIMO	431303	364285	5140219	7	23	2003	43	13	A	M	NO	YES	141	33	17	12	32
MIPE	190602	366394	5140813	8	1	2002	19	6	A	M	YES	YES	160	46	18	11	51
MIPE	212502	366508	5142154	8	1	2002	21	25	A	F	YES	YES	157	43	20	13.5	50
MIPE	421603	364925	5140175	7	14	2003	42	16	S	M	NO	YES	1000	26	18	8	13
MUMU	4226	364806	5141193	7	25	2003	31	21	A	M	YES	YES	169	91	20	15	21
PEMA	120803	364492	5139730	7	9	2003	12	8	A	F	YES	YES	174	77	20	18	25
PEMA	351703	366731	5141579	7	24	2003	35	17	A	F	YES	YES	177	76	21	19	32
PEMA	361103	366439	5141880	7	22	2003	36	11	S	F	YES	YES	120	57	19	17	11.5
PEMA	441602	364271	5140247	8	9	2002	44	16	S	F	YES	YES	142	61	20	17	20
SOCI	212002	366497	5142106	8	1	2002	21	20	A	F	YES	YES	105	41	10	4	9
SOCI	221703	365932	5140706	7	16	2003	22	17	A		NO	YES	89	32	12	7	4
SOCI	221802	365981	5140852	8	1	2002	22	18	S	F	NO	YES	89	35	11	7	2.5
SOCI	509902			7	31	2002	50		A	M	NO	YES	109	38	12	7	6
SOMO	181903	366387	5140384	7	16	2003	18	19	A	F	NO	YES	114	36	12	7	7
SOMO	500403	364688	5140300	7	15	2003	50	4	A	M	NO	YES	83	35	12	NA	3
SOPA	212302	365960	5140562	8	2	2002	21	23	A	F	YES	YES	149	19	17	2	9
SOVA	181603	366388	5140394	7	16	2003	18	16	A	M	NO	YES	98	40	13	8	4.8
SOVA	230102	366167	5140528	8	2	2002	23	1	A	F	NO	YES	101	40	12	7	6
SOVA	232202	366121	5140351	8	2	2002	23	22	A	M	YES	YES	104	41	12	4	7
SOVA	490202			7	31	2002	49	2	A	F	YES	YES	110	39	12	7	4
SOVA	510402			8	6	2002	51	4	A		NO	YES	78	39	13	8	5
TAAM	470602	DUMP		8	2	2002	47	6	A	F	YES	YES	220	93	31	14	50
TAAM	479903	DUMP		7	18	2003	47		A	F	YES	YES	220	99	32	21	46
THTA	999902	364638	5140249	7	26	2002			A		YES	YES	192	60	23	8	82

MIMO = *Microtus montanus*; MIPE = *Microtus pennsylvanicus*; MUMU = *Mus musculus*; PEMA = *Peromyscus maniculatus*; SOCI = *Sorex cinereus*; SOVA = *Sorex vagrans*; THAT = *Thomomys talpoides*; SOMO = *Sorex monticolus*; SOPA = *Sorex palustris*; TAAM = *Tamias amoenus*. Number is animal tracking number generally the transect (first two digits), station (second two digits), and year (last two digits), UTMs Datum is NAD83. Skin and Skull columns indicate if a skin and or skull were prepared as voucher specimens. Total is total length from tip of nose to tip of tail. Tail is tail length. All length measurements are in mm. All weights are in grams.